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Fall 2003

## Aquatic and Riparian Effectiveness Monitoring Program

Johanna Gillham  
*Western Washington University*

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**AREMP**



# **Aquatic and Riparian Effectiveness Monitoring Program**

**Johanna Gillham**

**Fall 2003**

**Advisor, Dr. Leo Bodensteiner, Ph.D.**

Honors Program

## HONORS THESIS

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## **2. SUMMARY**

I chose to use my experience as an employee of the U.S. Bureau of Land Management (BLM) in order to fulfill Huxley College graduation requirements, as well as Western Washington University (WWU) Honors Program requirements. Therefore, I completed a term position as a Biological Technician for the Aquatic Riparian Effectiveness Monitoring Program (AREMP) during the summer of 2003.

AREMP is the watershed condition module of the Interagency Regional Monitoring Program for President Bill Clinton's Northwest Forest Plan (NWFP). The NWFP encompasses more than 25 million acres of federally managed land in Western Washington and Oregon, and Northwestern California, and is largely based on the management of critical habitat for endangered species such as the Northern Spotted Owl and the Marbled Murrelet. It attempts to balance proper environmental stewardship with economic interests such as timber harvest in the Pacific Northwest. AREMP is one of seven modules developed in an interagency effort to monitor the effectiveness of the Northwest Forest Plan at meeting its intended goals.

I was hired through the BLM Student Temporary Employment Program (STEP) to be a member of a five-person field crew whose primary responsibility was to collect in-channel data. We collected morphological, physical, chemical and biological data in streams within the boundaries of the NWFP.

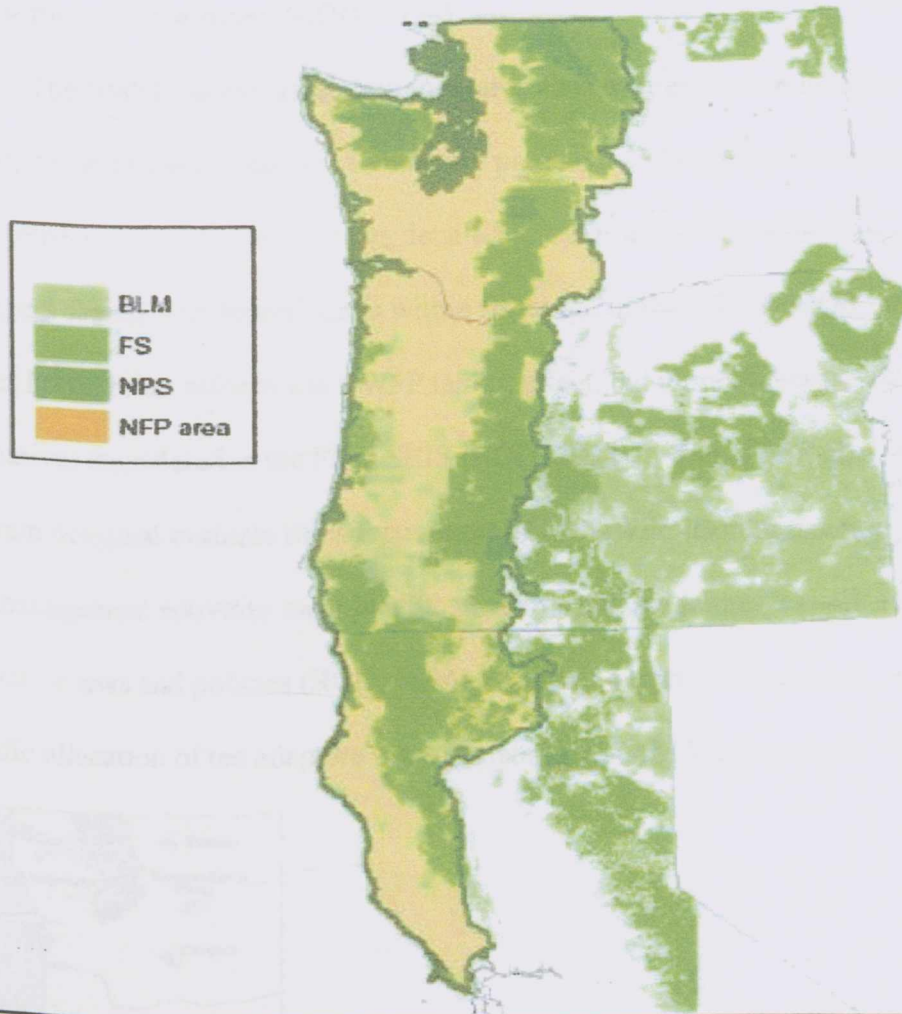
This report is not an official representation of any of the federal agencies or programs mentioned. Rather, it presents my position at AREMP in the context of public policy and summarizes the NWFP and Monitoring Program while recalling my experience as both a field technician and federal employee.

### 3. NORTHWEST FOREST PLAN

#### 3.1 Overview

Heated controversy over timber harvest, old-growth forest habitat and related species such as *Strix occidentalis caurina* (the northern spotted owl), an endangered species, has drawn attention to issues surrounding management of public lands, particularly forested lands, in the Pacific Northwest. In an effort to address both the economic and environmental value of federal forests in the Pacific Northwest and Northern California, President Bill Clinton requested the creation of a long-term, comprehensive policy for the management of public lands in the region. At the 1993 Forest Conference he spoke of the need to “protect the long-term health of our forests, our wildlife and our waterways” (ROD, 1994). The result was the Northwest Forest Plan (NWFP), which began in 1994, and is the result of an interagency, interdisciplinary effort lead by Dr. Jack Ward Thomas, former U.S. Forest Service (USFS) Chief. Numerous government agencies have interests and involvement with issues concerning management of late-successional and old-growth forest within the NWFP: the U.S. Department of Agriculture’s USFS, USFS Pacific Northwest Research Station, and Natural Resources Conservation Service (NRCS); the U.S. Department of the Interior’s BLM, National Park Service (NPS), Bureau of Indian Affairs (BIA), U.S. Fish and Wildlife Service (USFWS), and U.S. Geologic Survey (USGS); the U.S. Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NMFS); the Army Corps of Engineers; and U.S. Environmental Protection Agency (EPA) (REO, 2003). The NWFP marks the first time that the BLM and USFS have developed and adopted a common approach to land management for lands

that they administer throughout an entire ecological region (ROD, 1994). The Plan encompasses over 25 million acres of federal land defined by the range of *S. occidentalis caurina* (Figure 1).



**Figure 1.** Northwest Forest Plan boundaries, as defined by the range of *S. occidentalis caurina* (northern spotted owl) in Western Washington and Oregon, and Northern California (Moyer, 2003).

Fifty-four management strategies were initially proposed, and ten were discussed in the Final Supplemental Environmental Impact Statement (SEIS) (ROD, 1994). The Northwest Forest Plan was chosen as the best management direction “for providing a sustainable level of human use of the forest resource while still meeting the need to maintain and restore the late-

successional and old growth forest ecosystem” (ROD, 1994). It was designed to provide for maintenance and restoration of late-successional and old-growth forest ecosystems and protect critical riparian habitat, with the idea that it may provide a better connected network of old-growth forests in the future (ROD, 1994).

The NWFP adopts mitigation measures such as green tree retention, owl activity center protection, and riparian reserves to mitigate potentially adverse environmental impacts of management activities, and includes detailed *Standards and Guidelines* that describe how managers should treat federal lands within the range of the NWFP (ROD, 1994). It allows less timber harvest than prior to the NWFP taking effect, but more timber harvest than six of the 10 alternatives considered in the Final SEIS (ROD, 1994). The NWFP also includes a monitoring program designed evaluate the effectiveness of the NWFP itself at meeting its goals, by ensuring that management activities meet NWFP standards and guidelines, as well as comply with all applicable laws and policies (ROD, 1994). Another attractive component of the NWFP was the specific allocation of ten adaptive management areas (AMAs) (Figure 2).



**Figure 2.** Adaptive Management Areas (AMAs) in the Northwest Forest Plan. Each area is used to develop and test new management approaches (REO, 2003).



AMAs are areas designated for development and testing of new management approaches to achieving desired ecological, economic and social goals of the NWFP (ROD, 1994). Adaptive Management Areas are one of seven land allocation categories within the Plan.

### **3.2 Land Allocation Categories**

#### *Congressionally Reserved Areas*

Representing 30 percent of federal lands within the NWFP, these include National Parks and Monuments, Wilderness Areas, Wild and Scenic Rivers, National Wildlife Refuges, Department of Defense lands, and other lands with congressional designations (ROD, 1994).

#### *Late Successional Reserves*

Also representing 30 percent of federal lands within the NWFP, these are designed to serve as habitat for late-successional and old-growth related species and maintain a functional, interactive late-successional and old-growth forest ecosystem (ROD, 1994).

#### *Adaptive Management Areas*

Each area with this designation has a different emphasis for its intended use, and some timber harvest will come from these areas, which represent six percent of federal land within the range of the NWFP (ROD, 1994). These ten areas are intended for development and testing of new management approaches in order to meet ecological, economic and social goals of the NWFP. They range from 92,000 to nearly 500,000 acres, and most are associated with communities socially and economically impacted by reduced timber harvest from federal lands (REO, 2003).

### Managed Late Successional Areas

Comprising one percent of federal lands within the range of the NWFP, these areas are either mapped managed pair areas (delineated areas known for *S. occidentalis caurina* activity), or unmapped protection buffers designed to protect rare and endemic species (ROD, 1994).

### Administratively Withdrawn Areas

These areas represent six percent of federal land within the range of the NWFP, and include recreational and visual areas, back country, and other areas not scheduled for timber harvest, are identified in forest and district plans (ROD, 1994).

### Riparian Reserves

These areas represent eleven percent of federal lands within the NWFP, and include areas along streams, wetlands, and unstable or potentially unstable areas. They are designed to protect aquatic and riparian ecosystems and related species, while incidentally benefiting upland species (ROD, 1994). They are also intended to improve travel and dispersal corridors for terrestrial plants and animals, as well as connectivity of late-successional forest habitat (ROD, 1994).

### Matrix

Representing 16 percent of federal lands within the NWFP, this is federal land not allocated in the above designations, and is the area where the most timber harvest and other silvicultural activities take place (ROD, 1994). It also may contain forested or non-forested areas unsuitable for timber production (ROD, 1994).

### **3.3 Implementation and Monitoring**

The selected alternative provides a monitoring plan that builds on existing monitoring efforts, but also calls for the development of new monitoring protocols, criteria, goals and reporting formats (ROD, 1994). In an effort to enhance the usefulness of monitoring results, it requires monitoring at multiple levels and scales, as well as interagency coordination and compilation of information to ensure consideration of such information at the regional scale (ROD, 1994).

The White House Office on Environmental Policy, the Department of the Interior, the Department of Agriculture, the Department of Commerce and the Environmental Protection Agency entered into a formal procedure for interagency coordination called the Memorandum of Understanding for Forest Ecosystem Management (ROD, 1994). This memorandum created the Interagency Steering Committee, the Regional Interagency Executive Committee, and the Regional Ecosystem Office (ROD, 1994). The Regional Interagency Executive Committee is the highest authority in the Interagency Regional Monitoring Program, which administers AREMP.



## **4. INTERAGENCY REGIONAL MONITORING PROGRAM**

### **4.1 Overview**

The Interagency Regional Monitoring Program is a joint effort between the U.S. Department of the Interior's BLM, NPS, USFWS, BIA, and USGS; the U.S. Department of Agriculture's USFS; the EPA; and Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NMFS). The program is designed to assess the effectiveness of the NWFP in achieving its goals. It consists of a Regional Interagency Executive Committee, Interagency Monitoring Program Managers representing the eight federal agencies, and seven modules headed by members of an Interagency Regional Monitoring Team. The modules are designed to address regional-scale questions, and each module is directed at contributing to the ten-year comprehensive evaluation of NWFP effectiveness, to be published in 2004. The monitoring plan itself is also subject to periodic evaluation of its relevancy, and can be adjusted as necessary (ROD, 1994). In 2002 the approved Regional Monitoring Program budget was \$6.297 million, and was \$6.286 million in 2003 (Anonymous, 2003).

### **4.2 Monitoring Modules**

#### Implementation

This module is designed to document whether the NWFP *Record of Decision* and *Standards and Guidelines* are being consistently followed by agencies involved with issues concerning management of federal lands within the range of the NWFP (Anonymous, 2003). Randomly selected projects are monitored annually from 12 planning provinces within the Plan

(REO, 2003). Monitored projects include timber sales, mill and mining sites, and forest density management.

#### Late-Successional and Old-Growth (LSOG)

The LSOG module implements the Interagency Vegetation Mapping Project (IVMP), and is designed to assess status and trends of forest vegetation in 12 physiographic provinces within the NWFP (Anonymous, 2003). Remote sensing and GIS technology are used to map existing vegetation, as well as survey inventory plots to estimate amounts and characteristics of forest types (Anonymous, 2003). Remote sensing and repeat surveys are used to estimate changes in vegetation trends (Anonymous, 2003).

#### Northern Spotted Owl (NSO)

*Strix occidentalis caurina* (northern spotted owl) is federally listed as an endangered species and is associated with old-growth forest habitat. The purpose of the NSO module is to assess the NWFP's success at stabilizing or reversing the decline of *S. occidentalis* populations (Anonymous, 2003). NSO monitors the amount and distribution of nesting, roosting, foraging and dispersal habitat across eight demographic study areas (Anonymous, 2003). Maintenance and restoration of *S. occidentalis* habitat are also monitored on federal lands within the NWFP area. Data are being compiled with GIS software to produce habitat maps and develop models that predict population status based on the state of the habitat (REO, 2003).

#### Marbled Murrelet (MaMu)

*Brachyramphus marmoratus* (marbled murrelet) is federally listed as a threatened species in Washington, Oregon and California. It feeds at sea and uses old forested habitat for nesting. This module uses "at-sea" random transect surveys to estimate population and density, and

monitor trends of *B. marmoratus* across five conservation zones (Anonymous, 2003). Aerial photographs and satellite imagery of nesting sites, as well as vegetation measurements at nesting sites and random sites, are used to create models that estimate the amount and distribution of suitable habitat (Anonymous, 2003). These models will eventually be used to reveal changes in habitat over time within the range of the NWFP (Anonymous, 2003).

### *Social and Economic*

This module evaluates whether communities and economies within the range of the NWFP are experiencing positive or negative changes that may be associated with federal forest management, and whether predictable levels of timber and non-timber resources are available and being produced (Anonymous, 2003). Important components of this module include delineation and description of small communities within the NWFP area, use of mixed-methods case studies to describe socioeconomic changes and interactions in sample communities, and monitoring of forest actions including contracting, hiring, and grant disbursement (Anonymous, 2003).

### *Tribal*

Seventy-six tribes have rights and interests in the area covered by the NWFP, which includes a commitment to monitoring effects of land management on tribal rights, interests and access to resources (Anonymous, 2003). This module assesses the effectiveness of federal agency consultation with indigenous tribal governments, and ensures that tribal rights and interests are considered in agency decisions (Anonymous, 2003). Treaty and non-treaty fishing rights, water rights and access to culturally important resources are examples of such considerations in agency decisions.

### Watershed Condition

Also known as the Aquatic Riparian Effectiveness Monitoring Program (AREMP), this module is charged with assessing the ecological condition of watersheds within the range of the NWFP. Data from aquatic, riparian and upslope ecosystems are used to analyze trends in watershed, stream and riparian conditions, determine ecosystem status indicators, develop predictive models, and develop ecosystem management decision support models (DMSs) (Anonymous, 2003).

## 5. AQUATIC RIPARIAN EFFECTIVENESS MONITORING PROGRAM (AREMP)

### 5.1 Overview

#### Purpose and Goals

AREMP is headquartered in Corvallis, Oregon, at the USFS Siuslaw National Forest Supervisor's Office. Its primary purpose is to assess current conditions of 6<sup>th</sup> field watersheds (a unit in a hierarchical hydrologic scale, 10,000 to 40,000 acres in size) within the NWFP and track changes in them over time (AREMP, 2003). Objectives include determining the effectiveness of the NWFP at restoring and maintaining watersheds and aquatic ecosystems, assessing changes in ecosystem status indicators, identifying elements that contribute to poor watershed condition, and providing information for adaptive management (Anonymous, 2003). AREMP has set a goal to sample 50 watersheds per year on a five-year rotation, for a total of 250 watersheds (AREMP, 2003).

#### Program Development

AREMP began gathering field data in 2000 with an emphasis on protocol development (Notes, 2003). One field crew sampled four watersheds that first year. A pilot project was launched in 2001, and four field crews sampled 16 watersheds (Notes, 2003). The first year of monitoring was 2002 with one Field Coordinator and five field crews that sampled 20 watersheds (Notes, 2003). The 2003 field season involved six field crews and a goal of sampling streams in 25 new watersheds and 11 repeat watersheds, for a total of 36 watersheds. The 2003 hierarchical staffing structure included the Module Leader, three Field Operations Scientists, three Field Coordinators, Six Crew Leaders and 24 Crew Members.

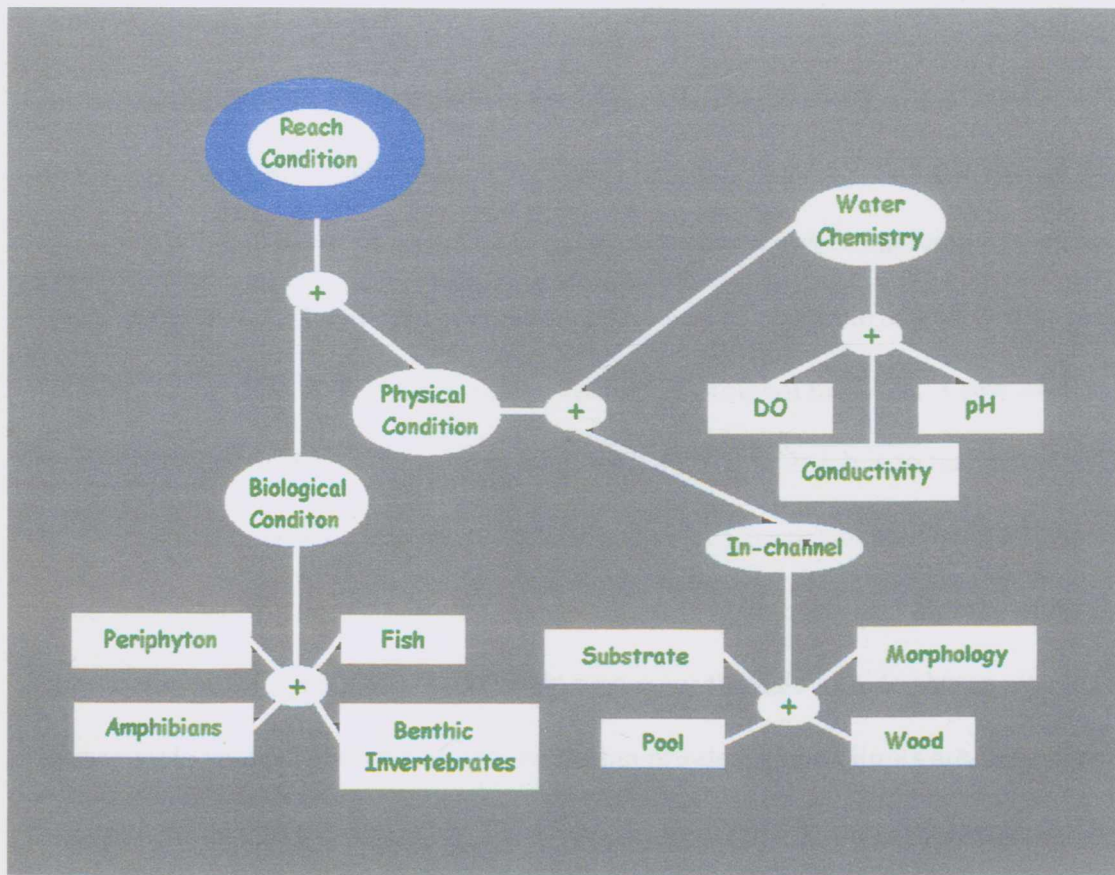
### Protocol Development

The 2003 field protocols were developed using multiple sources. Site layout and channel morphology sampling methods follow the EPA Environmental Monitoring and Assessment Program (EMAP) (Moyer, 2003). Wood survey methods came from the Oregon Department of Fish and Wildlife (ODFW) (Moyer, 2003). Benthic macroinvertebrate collection methods came from the River Invertebrate Prediction and Classification System (RIVPACS) (Moyer, 2003). Fine substrate measurement methods were derived from those developed by the Forest Service Region 5 Office (Moyer, 2003). Finally, terrestrial amphibian survey methods were based on methods developed by the Pacific Northwest Research Station Forestry Sciences Laboratory (CFSL) (Moyer, 2003).

## **5.2 Data Sources**

### In-channel

Onset Stowaway thermographs are secured into a portable metal housing and anchored in all watersheds in May before the field season starts (AREMP, 2003). They record temperature data from June 1 to October 1 during the field season (AREMP, 2003). Field crews are responsible for gathering morphological, physical, chemical and biological data at the stream reach scale (Figure 3), using both pencil and paper as well as high-tech data recorders (Moyer, 2003).



**Figure 3.** Components of reach condition based on data collected in the field (Moyer, 2003).

### Riparian and Upslope

Existing GIS map layers from the USFS, BLM and states are used in combination with aerial photographs to evaluate roads, vegetation, landslides and some chemical data at the watershed scale (Moyer, 2003). Data includes the density and number of road crossings, percent cover of both broadleaf and coniferous vegetation, and seral stage of coniferous forest systems (Moyer, 2003).



### Quality Control

Quality control for field data is multifaceted. During every tour at least one field crew is assigned to "QA/QC" watersheds. This means that they resurvey multiple stream reaches that have already been surveyed by AREMP crews, which can involve moving to a different watershed each day. Each crew member is also asked to complete an exit survey at the end of the field season that assesses crew understanding of protocol methods. Crew leaders act as liaisons between office staff and crew members. Part of their job is to make sure that all data sheets and electronic data sets are complete, and values are reasonable before returning them to office staff. An office staff member also looks for completeness and unreasonable values as data sheets come in from the field. The people who enter the data into databases also look for unreasonable values. Data which are not within pre-determined limits are flagged by Access as they are entered into the database. They also run macros in Access that screen the data for invalid values (such as a watershed code that is not in WA, OR, or CA). After data have been entered, data tables are printed and scanned to check for errors in data entry.

### **5.3 Data Analysis**

All data are ultimately mathematically manipulated so that they can be entered into an Ecosystem Management Decision Support model (EMDS). An EMDS is an extension of ArcGIS software, and is used to determine the condition of each watershed (Figure 4) (Moyer, 2003). It evaluates data from GIS layers, and outputs data in the form of tables and GIS layers. Through a series of calculations, queries and regression equations in the EMDS, each watershed is given a value, or score, representative of its ecological condition. Scores range from -1 to 1, where -1 indicates poor watershed condition and 1 indicates good condition. This information is



then used to create a visual representation of watershed condition throughout the NWFP which is helpful for examining trends and information on a regional scale (Figure 5).

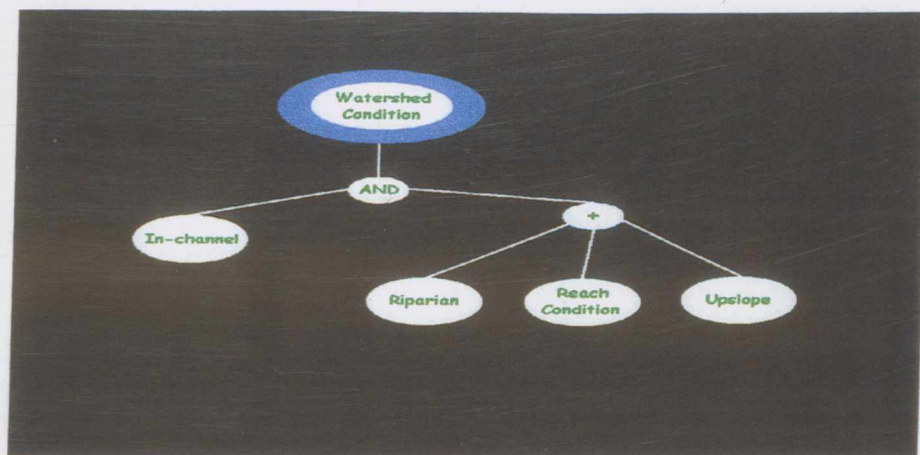


Figure 4. Components of watershed condition based on all data collected (Moyer, 2003).

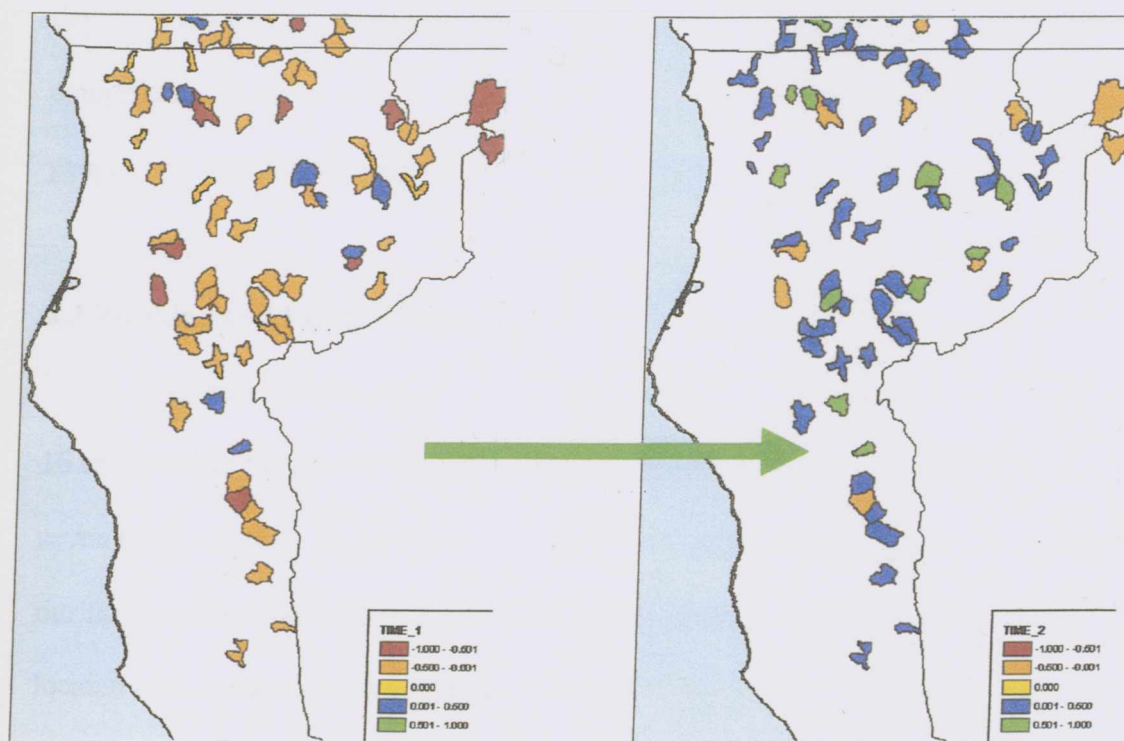


Figure 5. Sample AREMP GIS maps represent spatial and temporal watershed condition over time. Condition scores were derived from combination of all watershed data at both reach and watershed scale (Moyer, 2003).

## **6. MY EXPERIENCE AT AREMP**

### **6.1 Training**

My position as a Biological Technician and field crew-member began with a crash-course training session. About half to two-thirds of the field crew members were involved in a two-week training program including wilderness first aid, CPR, fish and amphibian identification, and practice using electronic data recorders. Training included simulated days in the field, practicing packing and carrying gear to and from sampling sites and familiarizing themselves with each job as well as the flow of sampling an entire site. This training program began before I had finished my spring quarter finals. I was hired anyway, along with the remainder of field crew members in the same situation. We received a two-day training session immediately prior to our first eight days working in the field. We spent one day filling out paperwork. The second day involved viewing a training presentation and then being introduced to the field protocols and equipment, as well as taking a CPR certification course. Field crews were a balanced mix of people who had attended either of the training sessions.

### **6.2 Working and Living Conditions**

The term position began June 2, 2003, and terminated September 30, 2003. I started June 16 and finished September 17, due to school obligations, and worked a total of 612 hours in seven tours, or stints, as we called them. We eight days of work with six days off. We camped during every tour, sometimes in established campgrounds, but mostly in a place conveniently located near our survey sites, usually a pull-out or primitive forest service road. Some crews had to backpack into their sites for days at a time. AREMP provided us with all of our work gear, including backpacks, hardhats, chest waders, wading boots, and sampling equipment. They also

provided every crew-member with a tent, and every crew with propane, stoves, lanterns, water filters and jugs, dishes, first-aid supplies, vehicles, and coolers. We were responsible for our food and personal gear, including clothing and sleeping bags. We left camp for work each day at 7:30 in the morning and returned any time between 6:00 and 8:30 at night, depending on where the site was and how sampling went that day. Some sites were located next to roads, while others required as much as a two-hour hike in. Hikes were almost never on trails, were usually steep, and we often had to flag our path on the way in or take a GPS waypoint of our vehicles to ensure finding our way back out. We worked and lived in all kinds of weather, from four straight days of rain and water inside our tents to temperature extremes ranging from over 100°F to below freezing. The only weather condition that prevented work was lightning, and on two occasions we were able to stay in a hotel room to dry out. No one at AREMP sustained serious injuries all summer. I made it through with only two bee stings and a sprained ankle. Other people had ticks, cuts, and sticks in the eye. The experience overall involved a lot of problem-solving, hard work, excitement, and fun.

### **6.3 Gathering Data**

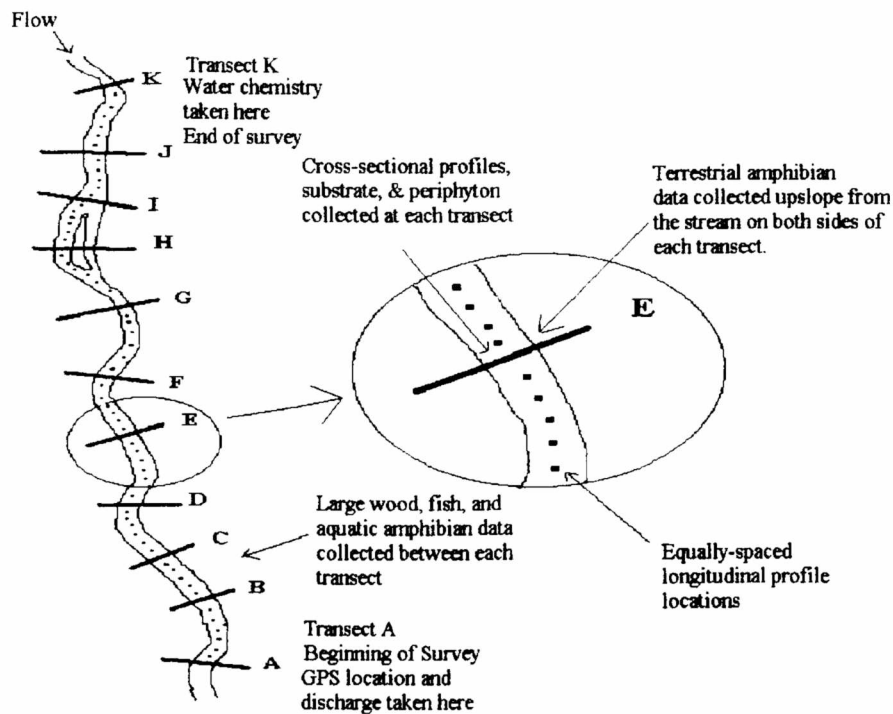
#### Site Selection

Watersheds and survey sites within them were randomly selected using a Generalized Random Tessellation Stratified design (GRTS) developed by the EPA (Moyer, 2003), which basically means that a computer randomly selected 80 survey sites per watershed. The random nature of site selection made some survey sites inaccessible. For example, sites on private land, on a glacier, or in a lake could not be surveyed (AREMP, 2003). Randomly chosen sites sometimes did not meet size requirements as designated by field protocols. Surveyable streams

were defined as having a minimum wetted width of 1.0 m and minimum depth in riffle habitats of 0.1 m, and must also not be so large that crews would be put in danger while sampling (AREMP, 2003). In order to prevent wasted time due to these variables, a reconnaissance team was employed during the 2003 field season. Recon crew members hiked into watersheds to determine which sites field crews would be able to sample, flag them, take a Globally Positioning System (GPS) waypoint, and then provide crews with directions to sites. Most site locations were pre-programmed into GPS units before crews left for the field. We used these in combination with quad maps, and sometimes a compass, to locate sampling sites once in the field. We finished surveying anywhere from four to eight sites in each watershed visited, and typically surveyed one site per day.

#### Site Layout

The location and amount of actual sampling was strongly dependant on interpretive decisions made about each individual site. Once we found our creek we had to determine a starting point, which we called Transect A. Starting points were defined by protocols as the pool tail crest nearest to the actual GPS location. Pool tail crests are defined as the downstream edge of a pool, where the habitat gradually decreases in depth and water increases in velocity. If no pools were present within 50 m up or down stream from the GPS point, a riffle could be used, and if there was some impassible obstacle upstream of the site (e.g. a large waterfall), the GPS start point could be designated instead as the stop point of the survey. Once Transect A was located we took a GPS waypoint of our starting point. We would then proceed with laying out the site in such a way that data collected could be later located in designated areas along the sampled stream reach (Figure 6).

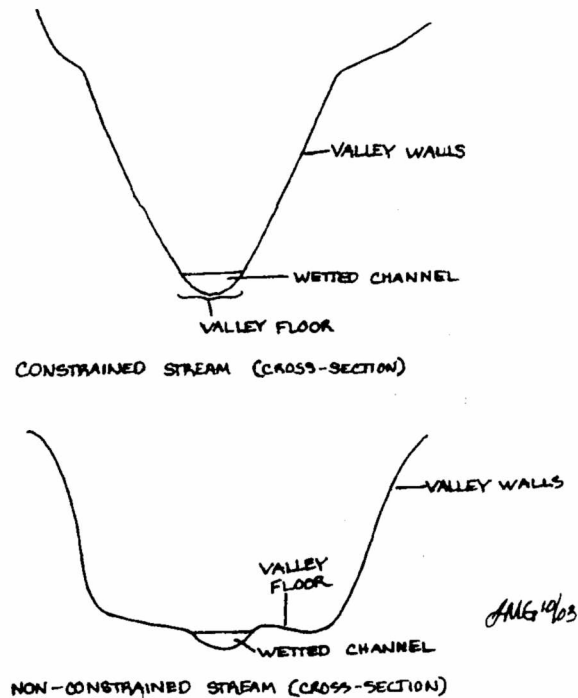


**Figure 6.** AREMP 2003 site layout and sampling strategy (AREMP, 2003).

For example, if an amphibian was found, its location in the stream would be recorded along with information about that particular animal. We laid out sites in terms of cross-sectional transects and longitudinal profiles that fell between each transect.

Every site is laid out with 11 transects, starting at Transect A and moving upstream (note exception above). Transects were lettered A through F with intermediate transects (A2, B2, etc.) for constrained stream reaches, and A through K for non-constrained reaches. The designation of constrained or non-constrained is a way to describe the cross-sectional shape of the valley that a stream is flowing through, and determined how surveying and sampling were done at each site (Figure 7). These designations are based on a Valley Width Index (VWI) that depends on the distance between the valley walls at the valley floor. A constrained reach typically has a high

gradient and narrow valley width, while a non-constrained reach typically has a low gradient and broad valley floor, and as a result, often has more sinuosity (AREMP, 2003). We made this determination with visual surveys of the valley floor outside of the stream channel along the length of the sample site.



**Figure 7.** Cross-sectional view of constrained vs. non-constrained basin shape.

When laying out a sample site we also needed to know where the bankfull elevation fell. As a rule of thumb, the bankfull elevation is the height or flow at which water fills the active channel, and the point at which water begins to flow onto the floodplain (AREMP, 2003). Since we sampled during the summer field season water in the channel was not at bankfull levels, and the decision involved some sleuthing. The determination was subject to interpretation, but was made based on any one of six indicators, including mature woody vegetation, depositional features, slope breaks, undercut banks, and particle size distribution (AREMP, 2003). The

lengths of streams that we sampled were proportionally based on the width of the channel at the bankfull elevation at transect A, and were anywhere from 160 to 480 m long. Just as the starting point had to be on a pool tail crest, so did the stopping point. Once initial site length was determined, an appropriate distance was added to give the total site length and account for the location of the stopping point. This distance was then divided by ten to determine the spacing of transects and length of longitudinals.

Finally, pools in the reach were included in site layout. Pools and riffles constitute different types of habitat and support different organisms. The presence of pools in a sampling site was also subject to interpretation based on protocol definitions. The protocol listed many requirements for an area along the stream to be considered a pool: the thalweg (longitudinal demarcation line in the water indicating zone of constant flow and maximum depth) must run through it, it must be bound by an upstream break in slope and downstream break in slope, be concave in profile, occupy more than half of the wetted channel width, be at least 1.5 times deeper at its maximum depth than at its tail, and be longer than it is wide (AREMP, 2003). One person was in charge of designating pools in each sampling site to reduce variability.

### Channel Morphology

We used a digital camera and tripod mid-stream at Transect A of each site to take a 360 degree panoramic photograph representative of the riparian habitat. These photographs are linked to GIS software for interpretation of field data and are intended as a tool to relay information to the public (AREMP, 2003). Ideally, they will be taken every five years during repeat surveys, and so they are also used as a tool to assess changes in the area over time (AREMP, 2003).



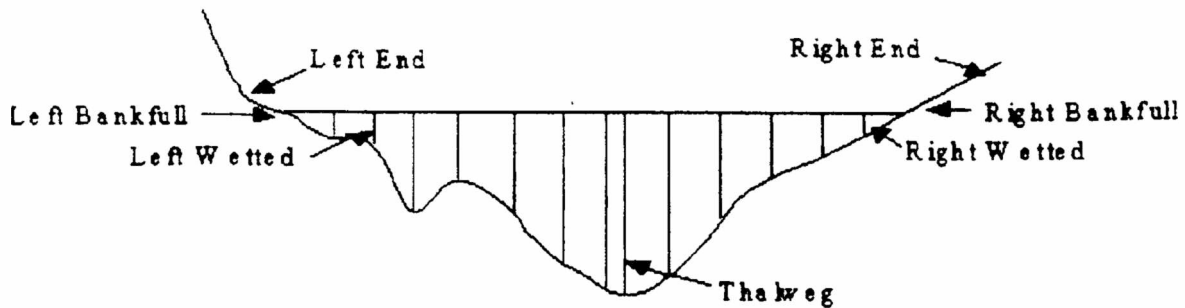
Morphological features of stream ecosystems are indicative of channel condition and ecosystem health in both aquatic and riparian habitats (AREMP, 2003). One of the most time-consuming tasks in the field was to produce a digital map of the stream channel. To do this we used a tripod with an electronic compass and laser connected to a small computer unit (HP 48) running Tripod Data Systems (TDS) software, and a prism on an adjustable pole (Figure 8).



**Figure 8.** From left to right: channel morphology mapping equipment including HP 48, laser, and compass from foreground to background (REO, 2003); field crew member running laser set-up (foreground) to capture prism points (background) (Moyer, 2003).

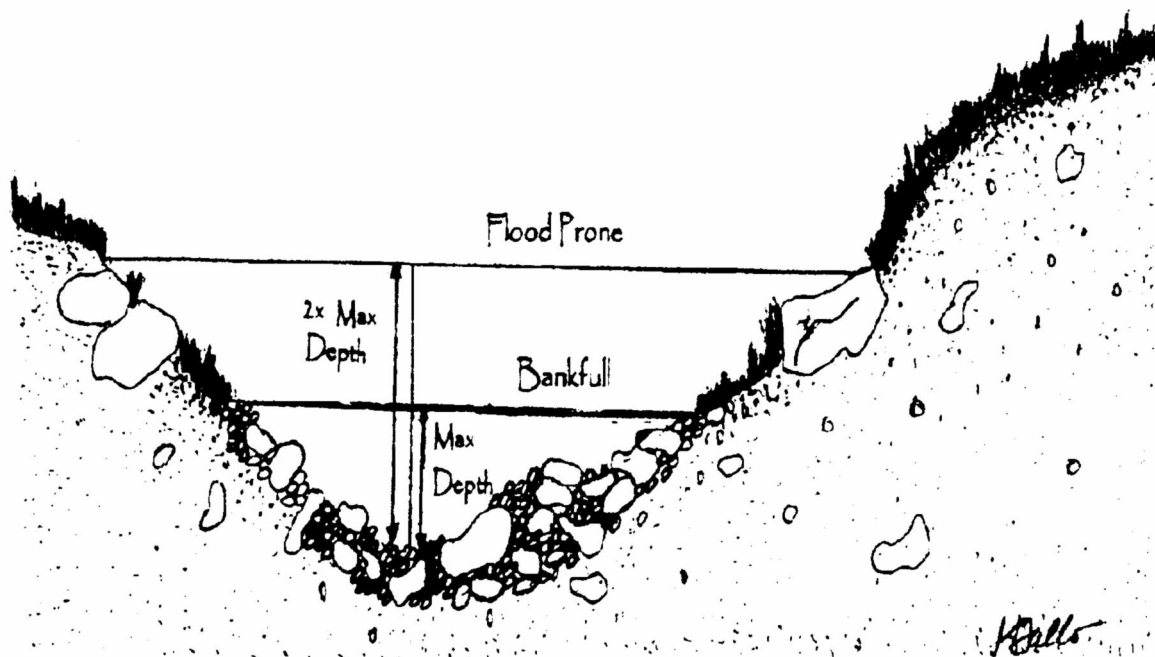
We calibrated the compass at each site and adjusted the declination in the compass for each watershed. The prism would be placed at equal intervals and predetermined locations along each cross-sectional transect and at longitudinal increments proportional to the reach length, including all designated pool areas, in the thalweg of the stream (Figure 9). Holding the prism often meant getting really wet or even swimming in the deeper pools of warmer creeks. The laser would then be bounced off of the prism at each point.





**Figure 9.** Cross-section of stream designating prism points captured at every transect (AREMP, 2003).

The compass orients each prism point in reference to an initial starting point and elevation at Transect A, and the computer is used to record the point location and elevation. Variables such as channel sinuosity, brush density along stream banks and reach length influenced the amount of time it took to complete this task, and how many times the laser set-up had to be moved upstream (traversed) in order to capture prism points. Two transects were randomly selected by a computer (pre-recorded on data sheets) and designated as “flood prone”. These transects required additional cross-sectional survey with the laser in order to capture the flood prone width of the channel, in other words, two times the maximum depth of the channel at the transect (Figure 10) (AREMP, 2003). Capturing flood prone transects in non-constrained reaches could involve traversing the laser across the entire valley floor, sometimes hundreds of meters. Cross-sectional profiles resulted in information about stream width and depth, streambed and bank shape, bankfull elevation, and flood prone areas on the valley floor (AREMP, 2003). Longitudinal profiles provided information about stream gradient, frequency of pools, and sinuosity (AREMP, 2003). Data recorded in the HP 48 was downloaded into Microsoft Excel files after each sampling day in order to produce a simple map.



**Figure 10.** Flood prone width of a channel based on the depth at the bankfull elevation (AREMP, 2003).

### Physical Habitat

Streambed and bank substrates are indicative of channel formation, maintenance, and stability (AREMP, 2003). Increased sediment input into streams can be the result of disturbance. Sediment load in streams is important to aquatic organisms, including aquatic food production, and survival of young fish (AREMP, 2003). We measured substrate by doing pebble counts at equal intervals along every transect and intermediate transect within bankfull elevation (11 transects regardless of constrained or non-constrained). To do this a rock was selected blindly at every interval and measured using a meter stick. Grainy mud was considered sand, smooth mud was considered silt, anything over 2 mm was measured, and anything large enough to park a car on was considered bedrock. If an obstruction such as a log was in the way it was important to classify the substrate underneath it if at all possible. We also counted fine substrates at three

locations across the pool tail crest of the first 12 designated pools moving upstream. To do this we used a 14 x 14 inch grid with seven horizontal and vertical partitions, and counted the number of intersections in the grid (50 total) where substrate both less than 6 mm and less than 2 mm was present.

Large pieces of wood influence channel width and meander patterns, provide sediment storage, and influence pool formation in small streams, as well as provide habitat for insects and amphibians, and cover for fish (AREMP, 2003). We counted wood within imaginary vertical bankfull walls of the channel, provided that it was a minimum 3 m long and 0.3 m in diameter at breast height (DBH). We noted the location of the wood, including which transect or longitudinal it was in, and whether it was over, on the side of, on an island in, across the full width of, or in the middle of the channel (AREMP, 2003). We also noted percent submergence, if it was cut or fell naturally, if it had an attached root wad, and how many other qualifying pieces it was touching, if any (AREMP, 2003). To improve efficiency two people gathered wood data. One person measured length and DBH of each piece of wood, while the other person estimated measurements without knowing actual ones. Once ten estimates and measurements were recorded, every piece was estimated and only every fifth piece needed to be measured because the estimations could be calibrated (AREMP, 2003). If five or more qualifying pieces were touching it was considered a log jam, and pieces were not measured, only counted.

### Water

We measured stream discharge (the velocity per area of flowing water) with an electronic flow meter at 10 equal intervals along one cross-section of each sampling site. This location was independent of site transects, and chosen based on characteristics that provide a representation of

actual stream flow, including laminar flow across the wetted width, no eddies, and no large rocks or wood (Authors, 2003). We used an unbroken water surface as a rule of thumb for identifying areas of laminar flow.

We collected a water sample for nutrient analysis including total nitrogen and total phosphorus from each watershed. It was always collected at a place below all tributaries in the watershed along a main stem river, in order to get a representative sample of nutrients in the whole watershed. We also used an electronic YSI meter and probe to collect site-specific water chemistry data. We used these instruments to collect temperature, conductivity, specific conductance, pH, and dissolved oxygen data for a minimum of two hours at each site. We calibrated the YSI meter and probe for each day of use (once per sampling site), mostly to account for elevation in dissolved oxygen measurements.

### Biota

We produced one sample of benthic periphyton for each sampling site. We collected one sub-sample using either a toothbrush to scrub 12 cm<sup>2</sup> of the surface of a submerged rock, or a syringe to vacuum substrate if a rock was not available, at every transect and intermediate transect for a total of 11 sub-samples per site. Chosen sampling spots alternated between left, center, and right (facing upstream, in that order) within the wetted width of the channel. We rinsed all sub-samples into a small sample bottle filled with creek water. Periphyton samples were preserved each night in camp with formalin.

We also produced one sample of benthic macroinvertebrates per site. Each sample contained eight sub-samples, two per riffle starting at the first riffle upstream of Transect A and continuing upstream through the next three riffle habitats. We used a kicknet to collect each sub-

sample, placing it so that stream flow would wash invertebrates into the net, and then used a brush to scrub rocks within a 1 x 1 foot area, followed by disturbing the area for approximately 30 seconds with our boots. Invertebrate samples were preserved each night in camp with 95 % ethanol (AREMP, 2003).

We also did presence/absence surveys of terrestrial amphibians as well as fish and aquatic amphibians. Each side of the channel was searched for five minutes at every transect (six total for constrained and 11 total for non-constrained reaches) for terrestrial amphibians. Surveyors then estimated the area they searched to create an effort (area searched per unit time). If one was found we identified it and recorded its location (both transect and habitat), snout-vent length, total length (excluding frogs), and life-history stage. If we could not identify it we took pictures.

We used an electrofisher backpack unit to survey aquatic vertebrates, recording species and number captured, water temperature, electrofisher settings, any mortalities, and effort (time shocking) for each longitudinal (five total for constrained, and 10 for non-constrained reaches). In addition to identification, we recorded displacement of all aquatic vertebrates, fork length of fish, and snout-vent length, total length and life-history stage of aquatic amphibians in the longitudinals immediately following flood-prone transects. We did not electrofish in streams with water temperatures exceeding 18°C, or containing known populations of endangered species such as Bull Trout or Coho Salmon. Vertebrates encountered outside of protocol searches were considered “incidentals”, and their species, lengths and locations were recorded separately.

## 7. CONCLUSION

The nature of this job was different than any other that I've had. Working so closely and in isolated conditions with the same group of people was trying at times. Not many people go home from work at night only to find that their co-workers and supervisors are also their roommates. For the most part, we had a lot of fun and became very close, but I also learned a lot about communication, compromise and maintaining a professional attitude.

For me this job was an introduction to working in the field, and I learned that just about anything can and will go wrong. Some frustrations were unavoidable; for example, some of our electronic equipment including the laser and electrofisher simply wouldn't work in the rain. Other problems included vehicle break-downs, equipment failures, radios and GPS units not working in deep canyons, and injuries, including poison oak rashes. Other crews experienced theft and other negative interactions with the public. We were often faced with public opinion about the government in general as well as the USFS and BLM. Some people were genuinely interested in what we were doing in the streams, and wanted to know about the condition of streams in their area. Others gave dirty looks, made snide comments, or did not acknowledge our presence at all. Overall these experiences were positive, and improved my ability to cope with a politically charged situation, as well as unexpected changes in my working environment and my personal life.

I was given the opportunity to explore my own backyard, so to speak, and saw many new places and some of the differences in streams and forests in our region. Substrate, riparian vegetation, water quality parameters, and animals present varied widely in streams that we surveyed. One of the most apparent differences in the forests that I worked in was the state of the forest floor, or duff layer, and how much potential forest fire fuel had built up in some areas,

particularly in pine forests. Additionally, I learned how to identify a number of amphibians, something that I hadn't encountered in the classroom, as well as *Salvelinus fontinalis* (Brook Trout), an invasive species in our region. I feel confident about my navigation skills, both on and off road, and my ability to survive with few creature comforts.

This experience met the purposes of the program requirements for both Huxley College and the WWU Honors Program, because for all intents and purposes I was immersed in a work area related to my field of study. I acquired numerous new job-specific skills involving navigation, animal identification, operation of survey equipment, and coping skills that I may not have encountered in the classroom. Finally, I can add a valuable reference to my resume that will undoubtedly improve my job search success in the future.

## 8. REFERENCES

- Anonymous. 2003. *Interagency Regional Monitoring Northwest Forest Plan-2002 Annual Report*. USDA Forest Service Pacific Northwest Region. R6-RMP-TP-02-03. 22p.
- AREMP. 2003. *Field Protocol Manual. Aquatic Riparian Effectiveness Monitoring Program*. Northwest Forest Plan Regional Interagency Monitoring. Corvallis, OR. 116 p.
- Moyer, C. 2003. AREMP Field Crew Training Microsoft PowerPoint Presentation. USFS Siuslaw National Forest Supervisor's Office, Corvallis, OR.
- Notes. 2003. Chris Moyer's Training for AREMP Field Crew Members, 06-16-03, 06-17-03. USFS Siuslaw National Forest Supervisor's Office, Corvallis, OR.
- REO. 2003. Regional Ecosystem Office Website. <<http://www.reo.gov>> Accessed 10 16-03.
- ROD. 1994. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl*. 74 p. Via Internet: <[www.or.blm.gov/Forest Plan/NWFPtitl.htm](http://www.or.blm.gov/Forest%20Plan/NWFPtitl.htm)> Accessed 10-13-03.



## 9. APPENDICES

### A. Creeks I Surveyed

<b>Creek Name</b>	<b>Land</b>	<b>Nearest Town</b>	<b>State</b>	<b>Date</b>
Threemile Creek	Winema NF	Chiloquin	OR	06/18/03-06/25/03
Crawford Creek	Kalmath NF	Cecilville	CA	07/02/03-07/09/03
West Fork Trail Creek	Medford BLM	Shady Cove	OR	07/16/03-07/23/03
Upper Camp Creek	Coos Bay BLM	Drain	OR	07/30/03-08/06-03
Draw Creek	Mt. Hood NF	Estacada	OR	08/13/03-08/20/03
Gold Creek	Okanogan NF	Twisp	WA	08/27/03-09/03/03
Cedar Creek*	Mt. Hood NF	Sandy	OR	09/10/03-09/17/03
Fifteenmile Creek*	Mt. Hood NF	Sandy	OR	09/10/03-09/17/03
Twin Falls Creek*	Gifford Pinchot NF	Cougar	WA	09/10/03-09/17/03
Alec Creek*	Gifford Pinchot NF	Cougar	WA	09/10/03-09/17/03
Elk Creek*	Gifford Pinchot NF	Cougar	WA	09/10/03-09/17/03

\* “QA/QC” (resurvey) sites

## B. Fish and Amphibians that I Identified in the Field

### Amphibians

Scientific Name	Common Name	Life History Stage: A=adult, L=larvae
<i>Ascaphus truei</i>	Tailed Frog	A,L
<i>Bufo boreas</i>	Western Toad	A
<i>Dicamptodon copei</i>	Cope's Giant Salamander	A (neotene)
<i>Dicamptodon tenebrosas</i>	Pacific Giant Salamander	A, A (neotene), L
<i>Pseudacris regilla</i>	Pacific Treefrog	A
<i>Plethodon dunni</i>	Dunn's Salamander	A
<i>Plethodon vehiculum</i>	Western Red-backed Salamander	A
<i>Rana aurora</i>	Red-legged Frog	A
<i>Rana boylei</i>	Foothills Yellow-legged Frog	A
<i>Rana cascadae</i>	Cascades Frog	A
<i>Rana catesbeiana</i>	Bullfrog	A, L
<i>Rana pretiosa</i>	Spotted Frog	A
<i>Rhyacotriton cascadae</i>	Cascade Torrent Salamander	A
<i>Taricha granulose</i>	Rough-skinned Newt	A

### Fish

Scientific Name	Common Name
<i>Cottus sp.</i>	Sculpin
<i>Oncorhynchus clarki</i>	Cutthroat Trout
<i>Oncorhynchus mykiss</i>	Rainbow Trout
<i>Rhinichthys sp.</i>	Dace
<i>Salvelinus fontinalis</i>	Brook Trout